

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
 Organization
 International Bureau



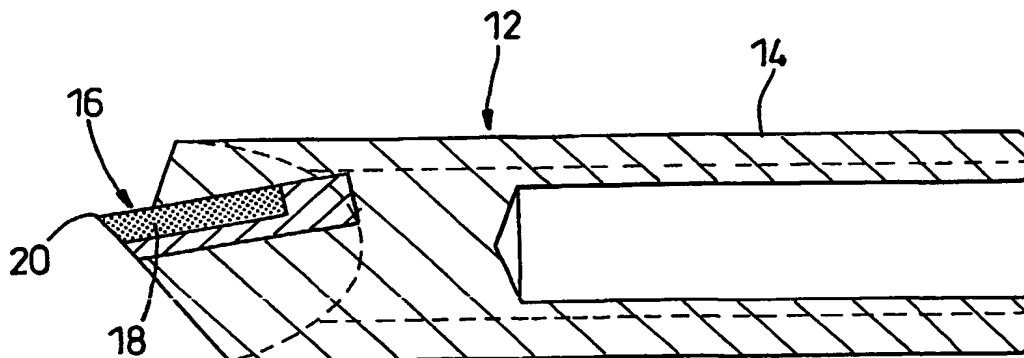
(43) International Publication Date
 22 January 2004 (22.01.2004)

PCT

(10) International Publication Number
WO 2004/007199 A1

- (51) International Patent Classification⁷: **B41C 1/045**
- (21) International Application Number:
 PCT/GB2003/000744
- (22) International Filing Date: 20 February 2003 (20.02.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
 0216303.8 13 July 2002 (13.07.2002) GB
- (71) Applicant (for all designated States except US): **KEATING GRAVURE SYSTEMS UK LIMITED [GB/GB]**; Unit 4, Bromfield Industrial Estate, Mold, Flintshire CH7 1HE (GB).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **KEATING, Michael [GB/GB]**; 25 Wycliffe Court, Hoole Lane, Chester CH2 3HA (GB).
- (74) Agents: **NEILL, Alastair, William et al.**; Appleyard Lees, 15 Clare Road, Halifax_HX1 2HY (GB).
- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:**
 — with international search report
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: IMPROVEMENTS IN AND RELATING TO GRAVURE PRINTING



(57) Abstract: The invention relates to a method of engraving a plurality of gravure cells in a surface, the method comprising the steps of: (a) mounting an engraving stylus comprising a stylus body inwardly tapering to the stylus tip, in an engraving head; (b) effecting penetration of the engraving stylus into the surface to a desired depth to produce a cell; (c) effecting partial withdrawal of the engraving stylus from the cell; (d) effecting relative movement between the stylus and the surface such that the partially withdrawn stylus effects engraving of a channel of shallower depth than the cell in the surface and having a channel width of at least 40% of the width of the previous cell engraved in the method; and (e) effecting further penetration of the engraving stylus into the surface to a desired depth, and effecting relative movement between the stylus and surface to produce a cell. The invention further relates to novel gravure engraving styli, comprising triangular prism, triangular prismoid or planar quadrilateral shaped tips.

Improvements In And Relating To Gravure Printing

Field of the Invention

5 This invention relates to methods of manufacturing gravure printing cylinders and to gravure printing styli.

Background to the Invention

10 Gravure printing is an intaglio process for long run high quality printing applications. The gravure printing process is a process whereby ink is transferred from small wells or cells that are engraved into the surface of a printing cylinder onto a suitable medium such as paper.

15 The cylinder is engraved by one of three common processes:

- (1) Chemical etching of the image;
- (2) Laser engraving of the cells onto the surface of the cylinder; and
- 20 (3) Electro-mechanically engraving individual cells into the surface of the cylinder.

Once the cylinder has been engraved by either process, the cylinder is rotated through a fountain of ink, and excess
25 ink removed by a doctor blade and returned to the ink fountain. An impression cylinder is used which is covered with a rubber composition that presses the printing paper, or other suitable material, into contact with the ink in the cells of the printing surface.

30

Gravure printing is capable of printing varying amounts and densities of ink to produce images that simulate continuous tone images. The cells that compose the images

on the printing cylinder vary in volume corresponding to the tonal values in the images.

In the case of laser gravure etching, it is capable of displaying etching speeds of up to 70,000 cells per second. However, laser etching involves the use of expensive laser equipment, which can be prohibitive in etching processes requiring only medium to high quality images, or in long run etching processes. Furthermore, many conventional printers have existing electro-mechanical engraving equipment, which would be costly to replace and upgrade to laser etching apparatus and processes.

Consequently, many gravure cylinders are made by electro-mechanical engraving systems which consist of three main parts. Firstly the system comprises an input unit which is generally a rotating drum on which a photographic printer is mounted in position and scanned by one or more reading heads. Secondly a computer processes the image densities recorded by the reading heads and converts them to electrical impulses that are transmitted to the third part of the system, an output unit consisting of a rotating copper plated cylinder on which are mounted one or more engraving heads with diamond styli that engrave the gravure cells in the copper cylinder corresponding to the strength of the electrical impulses from the computer.

Generally, the diamond stylus used in an electro-mechanical gravure engraving process is a diamond of triangular cross section, that engraves an inverted pyramid into the copper cylinder. This method produces a diamond or square shaped cell. A conventional gravure

cell pattern is shown in figure 1. Each line of cells comprises a plurality of adjacent cells (10) separated by a narrow channel (12), with each cell (10) in a column being positioned corner to corner with adjacent cells (10). Horizontal lines across the copper cylinder comprise offset cells which produces zig zag channels between adjacent columns and rows of cells on the cylinder as shown in Figure 1.

As can be seen from Figure 1, a disadvantage in using a diamond stylus of triangular cross section is the formation of a jagged zig-zag edge at the outermost column and row of cells (10) of an image. These jagged edges detract from the overall image quality, and cause images to have a grainy or jagged appearance.

It is desirable in any printing process to attempt to recreate the original image as perfectly as possible, including, in the case of recreating photographic or line drawing images, the continuous smooth edges of each image within the photograph or drawing. The use of diamond styli of triangular cross section in traditional gravure processes prevents smooth edged peripheral lines in the etched gravurel cylinder, and hence a subsequent print image from the cylinder will also correspondingly have non smooth peripheral lines.

It is therefore an aim of the preferred embodiment of the present invention to overcome or mitigate at least one of the problems of the prior art, whether expressly disclosed here above or not.

Summary of the Invention

According to a first aspect of the present invention there is provided a method of engraving a plurality of gravure
5 cells in a surface, the method comprising the steps of:

- (a) mounting an engraving stylus comprising a stylus body inwardly tapering to the stylus tip, in an engraving head;
- (b) effecting penetration of the engraving stylus into
10 the surface to a desired depth to produce a cell;
- (c) effecting partial withdrawal of the engraving stylus from the cell;
- (d) effecting relative movement between the stylus and the surface such that the partially withdrawn
15 stylus effects engraving of a channel of shallower depth than the cell in the surface and having a channel width of at least 40% of the width of the previous cell engraved in the method; and
- (e) effecting further penetration of the engraving
20 stylus into the surface to a desired depth, and effecting relative movement between the stylus and surface to produce a cell.

Preferably the method further comprises repeating steps
25 (c) to (e) at least one more time, preferably a plurality of times.

Suitably step (c) comprises withdrawing the stylus from the cell such that the channel formed during step (d) has
30 a width of substantially 45 - 65% of that of the previously engraved cell, preferably substantially 50%.

Thus when adjacent cells are the same depth and width are formed, having channels of substantially 45 - 65% width of the cells between each cell, the resultant line of cells have a substantially less jagged periphery than in conventional gravure printing where the channels are generally 15 - 20% of the width of adjacent cells.

The depth of penetration of the stylus during step (e) may be different to the depth of penetration in step (b). Thus, adjacent cells may have differing depth and width.

Suitably, penetration of the stylus is effected to produce cells having a width of between substantially 50 μ m to 80 μ m.

Suitably penetration of the stylus is effected to produce cells having a depth of between substantially 20 μ m to 35 μ m.

Suitably the spacing formed by the channel between adjacent cells is between substantially 14 μ m to 16 μ m long.

According to a second aspect of the present invention there is provided a method of engraving a gravure cell in a surface the method comprising the steps of:

- (a) mounting an engraving stylus in an engraving head;
- (b) effecting penetration of the engraving stylus into the surface to a desired depth to produce a cell;
- (c) passing direct current through the engraving head to effect continual penetration of the engraving stylus in the surface; and

- (d) effecting relevant movement between the stylus and the surface such that the continued penetration of the stylus effects elongation of the engraved cell.

5

Suitably the stylus comprises a stylus body which tapers inwardly to the stylus tip and the method further comprises the steps of:

- 10 (e) effecting partial withdrawal of the engraving stylus from the cell;
- (f) effecting relative movement between the stylus and the surface such that the partially withdrawn stylus effects engraving of a channel of shallower
- 15 depth than the previous cell in the surface; and
- (g) effecting further penetration of the engraving stylus into the surface to a desired depth, passing direct current through the engraving head and effecting further relative movement between
- 20 the stylus and surface to produce a cell.

Suitably the method further comprises repeating steps (c) to (g) at least one more time, preferably a plurality of times.

25

Thus this method may be used to produce elongated cells having substantially smooth peripheral edges, so that a line of adjacent cells at the periphery of an image engraved on the surface has a relatively smooth peripheral

30 edge compared to cells produced by conventional gravure printing which uses alternating current, which causes the engraving stylus to penetrate and withdraw from the surface quickly, and therefore forms non-elongated cells.

The depth of penetration of the stylus during step (g) may be different to the depth of penetration in step (b). Thus, adjacent cells may have differing depths and widths.

5

Suitably the penetration of the stylus is effected to produce cells having a width of between substantially 50 μ m to 80 μ m.

10 Suitably penetration of the stylus is effected to produce cells having a depth of between substantially 30 μ m to 100 μ m.

Suitably the spacing formed by the channel between
15 adjacent cells is between substantially 14 μ m to 16 μ m long.

Thus the method of the second aspect of the invention relies on direct current engraving, allowing an engraving image to be cut without the engraving head oscillating in
20 and out of the surface between two adjacent engraved cells/pixels. The result of this technique, especially with a quadrilateral-faced, planar-tipped stylus being used, gives an engraving image of increased volume compared to conventional engraving, but with straighter
25 horizontal and vertical edges in the cell rows and columns. The use of direct current allows the engraving apparatus to be run without any alternating current.

The method may further comprise effecting complete
30 withdrawal of the engraving head from the surface after a desired number of cells have been engraved, and subsequently effecting relative movement between the

stylus and the surface, before effecting further penetration of the engraving stylus into the surface to a desired depth to produce a cell, such that there is a portion of the surface which has not been engraved between
5 engraved cells. Thus a column of a desired number of cells may be engraved, followed by a non-engraved portion of the surface, after which the column of cells is continued, to a desired number of cells. There may be a plurality of non-engraved portions in any given column of
10 cells. Suitably, a non-engraved portion is effected between every 10 to 14 engraved cells.

The length of the non-engraved portion will vary depending on the screen ruling of the surface and the image to be
15 produced.

According to a third aspect of the present invention there is provided a gravure engraving stylus comprising a stylus holder on which is mounted a stylus body comprising a
20 triangular prismatic or triangular prismoid-shaped tip.

Suitably the tip is a triangular prismoid-shaped tip.

Suitably at least one angled face of the triangular
25 prismoid-shaped tip is trapezoid in shape, and preferably both angled faces are trapezoid in shape.

Preferably one or both of the faces of the triangular prism or triangular prismoid have a width of at least
30 substantially 10 μ m, more preferably at least substantially 12 μ m. Preferably one or both of the faces of the triangular prism or triangular prismoid has a width of not

more than 80 μ m, more preferably not more than 70 μ m and most preferably not more than 60 μ m.

Preferably the angle of the inward taper of the angled
5 faces to the apex of the triangular prism or prismoid is
between substantially 30° and substantially 90°, more
preferably between substantially 40° and 80°. Preferably
the angle of the inward taper is an angle selected from
the group consisting of substantially 50°, substantially
10 60°, substantially 70° and substantially 90°.

Suitably the stylus body is a diamond stylus body.

Suitably the stylus holder comprises an elongate member,
15 wherein the stylus body protrudes from one end of the
stylus holder at an angle of between substantially 15° and
35° to a longitudinal axis of the elongate member,
preferably between substantially 20° and 30°.

20 According to a fourth aspect of the present invention
there is provided a gravure engraving stylus comprising a
stylus holder on which is mounted a stylus body comprising
a planar quadrilateral-faced tip.

25 Suitably the stylus body comprises an inward taper to the
planar quadrilateral-faced tip.

Preferably, the face of the planar quadrilateral-faced tip
is perpendicular to the longitudinal axis of the stylus
30 body.

The planar quadrilateral-faced tip may be a rectangular-faced tip or a square-faced tip.

Preferably the tip is a square-faced tip.

5

Preferably the face of the square-faced tip has a width of at least substantially $10\mu\text{m}$, more preferably at least substantially $12\mu\text{m}$. Preferably the face of the square-faced tip has a width of not more than $80\mu\text{m}$, more
10 preferably not more than $70\mu\text{m}$ and most preferably not more than $60\mu\text{m}$.

Suitably the stylus body is a rectangular parallelepiped shaped body inwardly tapering towards the planar
15 quadrilateral-faced tip.

Preferably the angle of the inward taper is between substantially 30° and substantially 90° , more preferably between substantially 40° and 80° . Preferably the angle
20 of the inward taper is an angle selected from the group consisting of substantially 50° , substantially 60° , substantially 70° and substantially 80° .

Most preferably the stylus tip comprises a frustum of a
25 quadrilateral pyramid, inwardly tapering towards a square faced tip.

Preferably the stylus body is a diamond stylus body.

30 Suitably the stylus holder comprises an elongate member, wherein the stylus body protrudes from one end of the stylus holder at an angle of between substantially 15° and

35° to a longitudinal axis of the elongate member, preferably between substantially 20° and 30°.

5 According to a fifth aspect of the present invention there is provided a gravure engraving head on which is removably mounted a gravure engraving stylus of the second or third aspects of the invention.

10 According to a sixth aspect of the present invention there is provided a gravure engraving apparatus comprising an image scanning and processing means, operably connected to an engraving head of the fifth aspect of the invention, and an engraving surface, wherein, in use, scanned and processed information is transmitted from the image
15 scanning and processing means to the engraving head which effects movement of the engraving head to image-wise engrave the engraving surface.

20 The image scanning and processing means may be separate means and may be operably connected to the engraving head by way of electrical cable, telephone lines, satellite or by use of recordable media such as magnetic disks and tapes or optical media, for example.

25 According to a seventh aspect of the present invention there is provided a method of the first or second aspects of the invention using a stylus of the third or fourth aspects of the invention.

30 Description of the Drawings

For a better understanding of the invention, and show how embodiments of the same may be put into effect, the

invention will now be described by way of embodiment with reference to the following drawings, in which:

Figure 1 is an illustration of a gravure cell pattern,
5 engraved by a prior art gravure engraving process using an inverted triangular pyramid-shaped stylus tip;

Figure 2A illustrates a cross-sectional side view of a
gravure engraving stylus of the third aspect of the
10 invention;

Figure 2B shows an end view of the stylus of Figure 2A;

Figure 3 is an illustration of an engraved cell pattern,
15 engraved by the method of the first aspect of the invention using a gravure engraving stylus of the Figure 2A and 2B;

Figure 4 is an illustration of an engraved cell pattern,
20 engraved by the method of the second aspect of the invention using a gravure printing stylus of Figure 2A and 2B;

Figure 5 illustrates a side sectional view of a second
25 embodiment of a gravure engraving stylus of the invention;
and

Figure 6 illustrates a front end view of the engraving
stylus of Figure 5.

30

Description of a Preferred Embodiment

We refer firstly to Figures 2A and 2B, which illustrate a gravure printing stylus 16 of the third aspect of the invention. The stylus 16 comprises a stylus holder 14, which is cylindrical in shape, and in which is mounted a stylus 16 comprising a stylus body 18 which terminates at a triangular prismoid shaped tip 20. The triangular prismoid-shaped tip includes two angled faces 24 and 26, both of which are trapezoid in shape and which extend angularly to an elongate stylus apex 22.

10

Figure 3 shows an illustration of a partial image engraved into a copper plated gravure printing cylinder, the engraved image comprising columns of 100% cells 2 engraved using a gravure stylus 16 of the third aspect of the invention comprising a stylus holder 14 which is mounted a stylus body 18 inwardly tapering to the triangular-prismoid shaped tip 20 shown in Figures 2A and 2B. The stylus 16 used comprised a diamond stylus body and tip having mounted on a substantially cylindrical holder 14. The stylus body 18 was such that it protruded from one end of the stylus holder 14 at an angle of approximately 24° to the longitudinal axis of stylus body 18.

The engraving stylus was mounted in a engraving head (not shown).

Using AC current, the tip of the engraving stylus was penetrated into the copper plated surface to a depth of $30\mu\text{m}$. This produced a first cell 4. Using AC current, the tip of the engraving stylus was withdrawn from the copper plated surface partially, and the copper plated surface was rotated before the engraving tip was made to penetrate further into the surface to create the second

cell 8 upstream of the first cell 4. As the engraving tip was only partially withdrawn between engraving of the first cell 4 and the second cell 8, a channel 6 was produced between the two cells. The engraving tip was
5 only withdrawn to an extent that the channel 6 has a width of approximately half that of the width of the engraved cells. Thus, the pattern of cells is such that the outer
periphery 10 of the column of cells has a pseudo-continuous edge, as shown in Figure 3, as compared to the
10 jagged edges produced by penetration of a conventional triangular cross-section stylus tip, as shown in the illustration of a conventionally engraved image in Figure 1.

15 We refer now to Figure 4 which illustrates a partial image engraved on a copper plated engraving cylinder using the engraving stylus described for Figures 2A and 2B above. In this embodiment, the engraving stylus is arranged to penetrate the copper plate and using DC current, which
20 effects continuous penetration of the stylus in the copper plate whilst the cylinder is rotated, for a desired time and rotational distance. This has the effect, as shown in Figure 4, of producing an elongate cell having continual linear side edges. In order that the engraved cells have
25 sufficient strength in the cell walls, the engraving stylus must be removed partially from the copper plate at prescribed distances to create a channel between cells. To produce the image shown in Figure 4, the tip of the
stylus is partially withdrawn at prescribed intervals from
30 the copper plate for a distance of one cell. The use of a square-faced engraving stylus and DC current to maintain engraving and penetration of the stylus in the copper plate to create elongate cells, creates a substantially

true linear edge to the outside periphery of an engraved image. This effect is enhanced by providing for only partial withdrawal of the engraving tip at prescribed intervals to create channels of 50% width compared to the width of engraved cells. Thus, images produced as shown in Figure 4 will have smoother edges compared to prior art engraved images using traditional triangular cross section engraving styli which produce peripheral edges which are jagged, as shown in Figure 1.

10

In order to further prevent ink flooding out of the columns of engraved cells 8, for every 10 to 14 engraved cells 8, the stylus was completely withdrawn from the surface and the surface rotated to provide a cell-free gap, after which penetration of the surface was resumed to create further cells, as described above. The cell gap produced helps to prevent ink spillage from the cells when ink is loaded into the cells. The length of the cell gap will vary depending on conditions such as cell depth, image to be created, cell width, and screen ruling of the surface.

15

For the pattern produced in Figure 3, the following parameters of the engraving stylus shown in Figures 2A and 2B, the surface, the engraving screen and the method were employed:

20

Engraving screen:

35-160 lines per centimetre

30 Angle of stylus tip to surface 20°-60°

Stylus taper to stylus tip 50°-70°

Stylus bottom 20-100µm flat

Cell width 50-280µm

Vertical cell/pixel spacing variable

In further embodiments of the invention the gravure engraving stylus may comprise a triangular prismatic or triangular prismoidal shaped tip or a planar-quadrilateral faced tip (especially a square-faced tip). A particularly useful embodiment provides a gravure engraving stylus comprising a stylus tip comprising a frustum of a quadrilateral pyramid, inwardly tapering to a square-faced tip.

In embodiments wherein the gravure engraving stylus comprises a triangular prismoid-shaped tip, or triangular prismatic shaped tip, suitably both angled faces of the tip have a width of substantially $10\mu\text{m}$, preferably at least substantially $12\mu\text{m}$, and preferably one or both of the faces have a width of not more than $80\mu\text{m}$, and preferably not more than $70\mu\text{m}$ and most preferably not more than $60\mu\text{m}$. Suitably the angle of the inward taper of the angled faces to the apex of the triangular prism or prismoid is between substantially 30° and substantially 90° . In preferred embodiments the stylus holder comprises an elongate member and wherein the stylus body protrudes from one end of the stylus holder at an angle of between substantially 15° and 35° to a longitudinal axis of the elongate member.

Embodiments in which a planar quadrilateral faced tip is employed in the gravure engraving stylus, suitably the tip is a square faced tip, having a width of at least substantially $10\mu\text{m}$ and more preferably at least substantially $12\mu\text{m}$, and also preferably having a width of

no more than 80 μ m and preferably no more than 70 μ m. Suitably the angle of the inward taper of the square or quadrilateral face tip is between substantially 30° and substantially 90°.

5

In all embodiments, a preferred material for the stylus body and stylus tip is diamond.

We refer now to Figures 5 and 6. Figures 5 and 6
10 illustrate an embodiment of the gravure engraving stylus of the fourth aspect of the invention. The gravure stylus 16 is similar to the gravure stylus 16 of Figures 2A & 2B, and like numerals represent like components. The stylus 16 of Figures 5 and 6 comprises a planar quadrilateral-faced
15 tip 28 comprising an inwardly tapering section 30 which terminates at a planar square-faced apex 32, the face of the apex 32 being perpendicular to the longitudinal direction of the stylus body 18. Thus, the tip 28 takes the form of a frustum of a quadrilateral pyramid, inwardly
20 tapering to the square-face 28. Use of the gravure engraving stylus of Figure 5 & 6 is substantially identical to use of the stylus of Figures 2A & 2B, as described hereinabove.

25 The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and
30 documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and

drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

5

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated
10 otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the
15 foregoing embodiment(s). The invention extend to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any
20 method or process so disclosed.

Claims

1. A method of engraving a plurality of gravure cells in a surface, the method comprising the steps of:
 - 5 (a) mounting an engraving stylus comprising a stylus body inwardly tapering to the stylus tip, in an engraving head;
 - (b) effecting penetration of the engraving stylus into the surface to a desired depth to produce a cell;
 - 10 (c) effecting partial withdrawal of the engraving stylus from the cell;
 - (d) effecting relative movement between the stylus and the surface such that the partially withdrawn stylus effects engraving of a channel of shallower depth than the cell in the surface and having a channel width of at least 40% of the width of the previous cell engraved in the method; and
 - 15 (e) effecting further penetration of the engraving stylus into the surface to a desired depth, and effecting relative movement between the stylus and surface to produce a cell.
2. A method as claimed in Claim 1, further comprising repeating steps (c) to (e) at least one more time.
- 25 3. A method as claimed in Claim 1 or 2, wherein step (c) comprises withdrawing the stylus from the cell such that the channel formed during step (d) has a width of substantially 45 - 65% of that of the previously engraved cell, preferably substantially 50%.
- 30 4. A method as claimed in any one of Claims 1 to 3, wherein the depth of penetration of the stylus during

step (e) is different to the depth of penetration in step (b).

5. A method as claimed in any preceding claim, wherein
5 the penetration of the stylus is effected to produce cells having a width of between substantially 50 μ m to 80 μ m.
6. A method as claimed in preceding claim, wherein
10 penetration of the stylus is effected to produce cells having a depth of between substantially 20 μ m to 35 μ m.
7. A method of engraving a gravure cell in a surface the method comprising the steps of:
15
 - (a) mounting an engraving stylus in an engraving head;
 - (b) effecting penetration of the engraving stylus into the surface to a desired depth to produce a cell;
 - (c) passing direct current through the engraving head
20 to effect continual penetration of the engraving stylus in the surface; and
 - (d) effecting relevant movement between the stylus and the surface such that the continued penetration of the stylus effects elongation of the engraved
25 cell.
8. A method as claimed in Claim 7, wherein the stylus comprises a stylus body which tapers inwardly to the stylus tip and the method further comprises the steps
30 of:

- (e) effecting partial withdrawal of the engraving stylus from the cell;
- (f) effecting relative movement between the stylus and the surface such that the partially withdrawn stylus effects engraving of a channel of shallower depth than the previous cell in the surface; and
- (g) effecting further penetration of the engraving stylus into the surface to a desired depth, passing direct current through the engraving head and effecting further relative movement between the stylus and surface to produce a cell.
9. A method as claimed in Claim 8, wherein the method further comprises repeating steps (c) to (g) at least one more time, preferably a plurality of times.
10. A method as claimed in Claim 8 or 9, wherein the depth of penetration of the stylus during step (g) is different to the depth of penetration in step (b).
11. A method as claimed in any one of Claims 7 to 10, wherein penetration of the stylus is effected to produce cells having a width of between substantially 50µm to 80µm.
12. A method as claimed in any one of Claims 7 to 11, wherein penetration of the stylus is effected to produce cells having a depth of between substantially 30µm to 100µm.
13. A method as claimed in any one of Claims 7 to 12, further comprising effecting complete withdrawal of the engraving head from the surface after a desired

number of cells have been engraved, and subsequently effecting relative movement between the stylus and the surface, before effecting further penetration of the engraving stylus into the surface to a desired depth to produce a cell, such that there is a portion of the surface which has not been engraved between engraved cells.

14. A method as claimed in Claim 13, wherein there are a plurality of non-engraved portions in any given column of cells.

15. A method as claimed in Claim 14, wherein a non-engraved portion is effected between every 10 to 14 engraved cells.

16. A gravure engraving stylus comprising a stylus holder on which is mounted a stylus body comprising a triangular prismatic or triangular prismoid-shaped tip.

17. A gravure engraving stylus as claimed in Claim 16, wherein the tip is a triangular prismoid-shaped tip.

18. A gravure engraving stylus as claimed in Claim 17, wherein at least one angled face of the triangular prismoid-shaped tip is trapezoid in shape, and preferably both angled faces are trapezoid in shape.

19. A gravure engraving stylus as claimed in Claim 17 or 18, wherein both angled faces of the triangular prismoid-shaped tip are trapezoid in shape.

20. A gravure engraving stylus as claimed in any one of Claims 16 to 19, wherein one or both faces of the triangular prism or triangular prismoid have the width of at least 10 μ m.

5

21. A gravure engraving stylus as claimed in any one of Claims 16 to 20, wherein one or both faces of the triangular prism or triangular prismoid have a width of not more than 80 μ m

10

22. A gravure engraving stylus as claimed in any one of Claims 16 to 21, wherein the angle of the inward taper of the angle faces to the apex of the triangular prism or prismoid is between substantially 40° and substantially 90°

15

23. A gravure engraving stylus as claimed in any one of Claims 16 to 22, wherein the stylus is a diamond stylus.

20

24. A gravure engraving stylus as claimed in any one of Claims 16 to 23, wherein the stylus holder comprises an elongate member, wherein the stylus body protrudes from one end of the stylus holder at an angle of between substantially 15° and 35° to a longitudinal axis of the elongate member.

25

25. A gravure engraving stylus comprising a stylus holder on which is mounted a stylus body comprising a planar quadrilateral-faced tip.

30

26. A gravure engraving stylus as claimed in Claim 25, wherein the stylus body comprises an inward taper to the planar quadrilateral-faced tip.
- 5 27. A gravure engraving stylus as claimed in Claim 25 or 26, wherein the face of the planar quadrilateral-faced tip is perpendicular to the longitudinal axis of the stylus body.
- 10 28. A gravure engraving stylus as claimed in any one of Claims 25 to 27, wherein the planar quadrilateral-faced tip is a rectangular-faced tip or a square-faced tip or a square-faced tip.
- 15 29. A gravure engraving stylus as claimed in Claim 28, wherein the quadrilateral-faced tip having a width of at least substantially 10 μ m.
- 20 30. A gravure engraving stylus as claimed in any one of Claims 25 to 29, wherein the square-faced tip has a width of not more than 80 μ m.
- 25 31. A gravure engraving stylus as claimed in any one of Claims 25 to 30, wherein the stylus body is a rectangular parallelopiped shaped body inwardly tapering towards the planar quadrilateral-faced tip.
- 30 32. A gravure engraving stylus as claimed in Claim 31, wherein the angle of the inward taper is between substantially 40° and substantially 90°.

33. A gravure engraving stylus as claimed in any preceding claim, wherein the stylus tip comprises a frustum of a quadrilateral pyramid, inwardly tapering towards a square faced tip.
- 5 34. A gravure engraving stylus as claimed in any one of Claims 25 to 33, wherein the stylus body is a diamond stylus body.
- 10 35. A gravure engraving stylus as claimed in any one of Claims 25 to 35, wherein the stylus holder comprises an elongate member, and the stylus body protrudes from one end of the stylus holder at an angle of between substantially 15° and substantially 35° to a longitudinal axis of the elongate member.
- 15 36. A gravure engraving head on which is removably mounted a gravure engraving stylus of any one of Claims 16 to 24 or a gravure engraving stylus of any one of Claims 20 25 to 35.
- 25 37. A gravure engraving apparatus comprising an image scanning and processing means, operably connected to an engraving head as claimed in Claim 36, and an engraving surface, wherein in use, scanned and processed information is transmitted from the imaged scanning and processing means to the engraving head which effects movement of the engraving head to image-wise engrave the engraving surface.
- 30 38. A gravure engraving apparatus as claimed in Claim 37, wherein the image scanning and processing means are separate means.

39. A method as claimed in any one of Claims 1 to 15,
using a gravure stylus of any one of Claims 16 to 35.

5 40. A method substantially as described herein with
reference to the accompanying drawings.

41. A gravure engraving stylus substantially as described
herein, with reference to the accompany drawings.

10

42. A gravure engraving head substantially as described
herein, with reference to the accompanying drawings.

15 43. A gravure engraving apparatus substantially as
described herein, with reference to the accompanying
drawings.

1/4

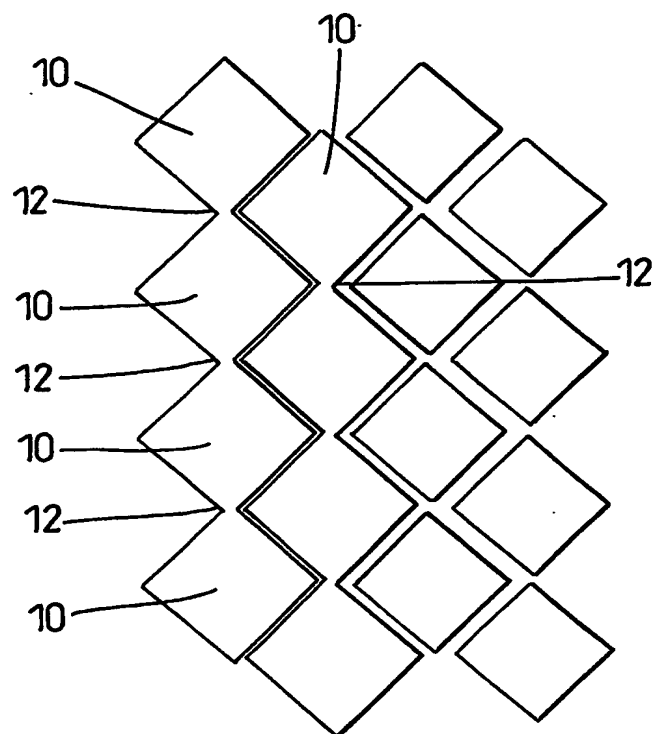


Fig. 1

2/4

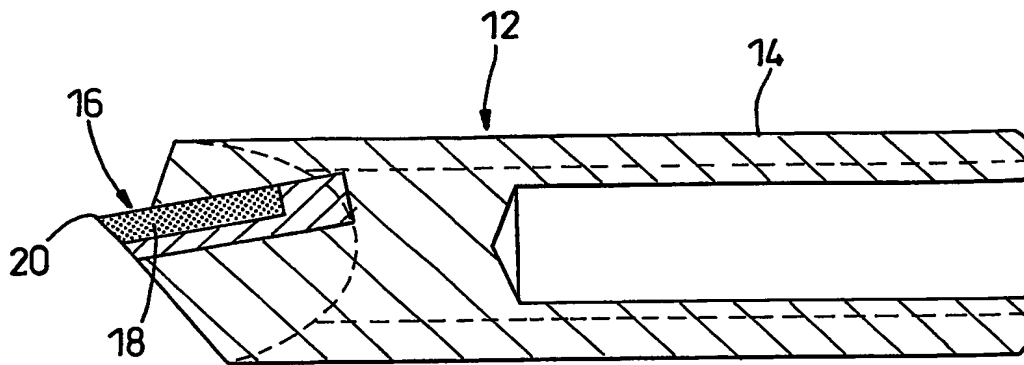


Fig. 2A

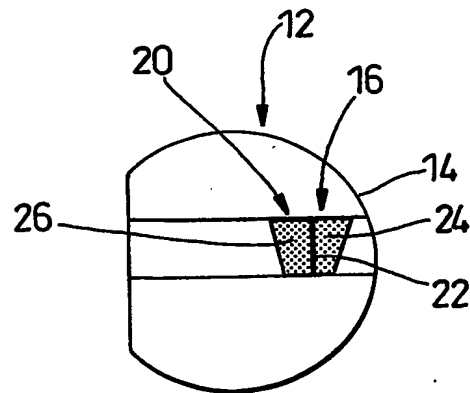


Fig. 2B

3/4

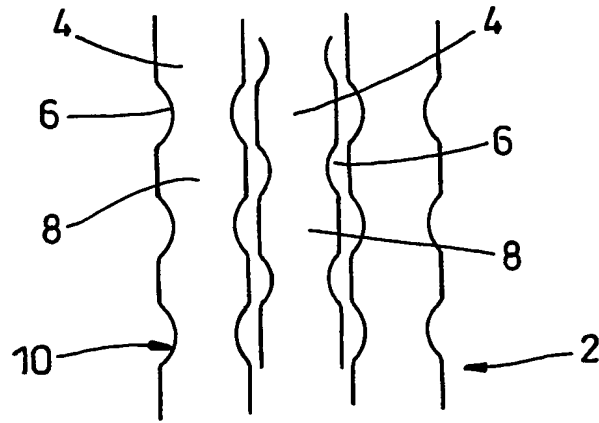


Fig. 3

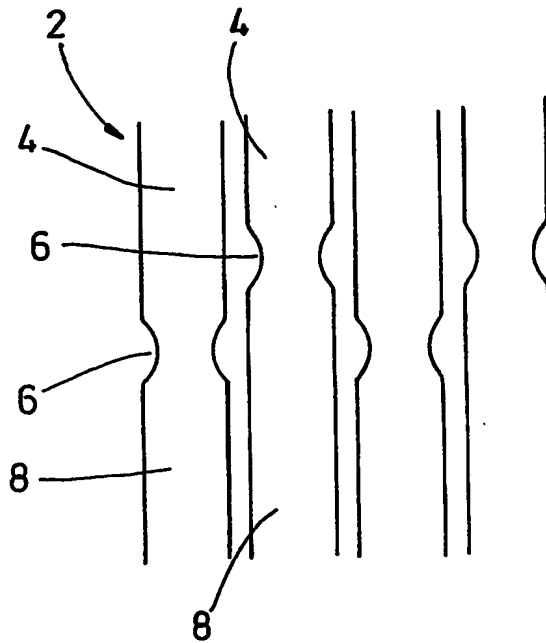
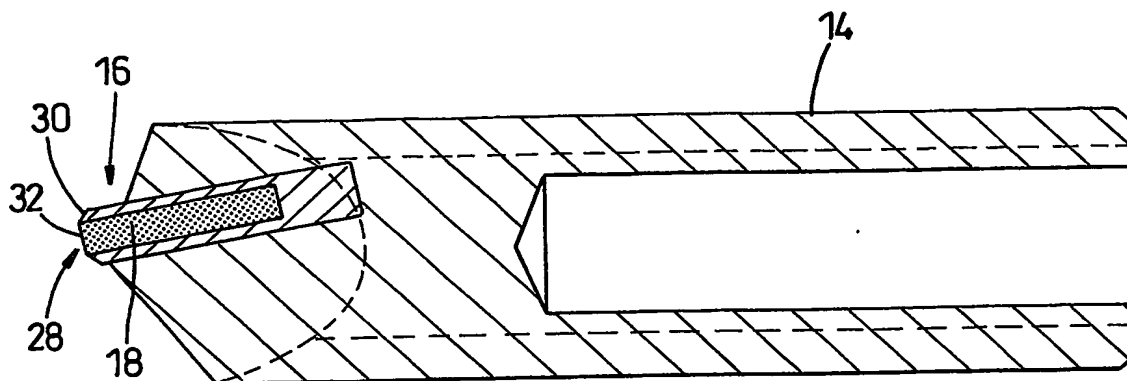
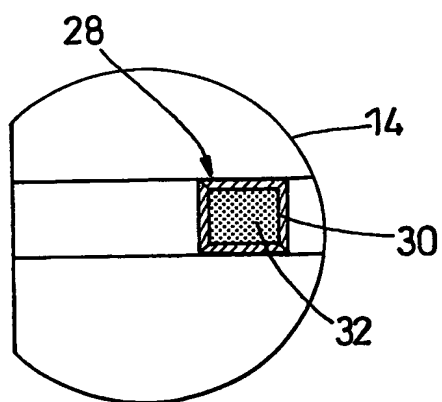


Fig. 4

4/4

*Fig. 5**Fig. 6*

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 03/00744

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B41C1/045

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B41C B44B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 491 559 A (BUECHLER LESTER W) 13 February 1996 (1996-02-13) column 8, line 4 - line 47; claim 1; figure 11	7-15, 39, 40
X A	DE 100 28 055 A (RATH HANS GUENTER ; REESE RUDOLF (DE)) 20 December 2001 (2001-12-20) column 5, line 9 - column 7, line 32; claims 1-8; figures 3,4	7, 11-14, 39, 40 8-10, 15
X A	US 4 451 856 A (BUECHLER LESTER W) 29 May 1984 (1984-05-29) column 4, line 60 - column 5, line 20; claims 1-3; figures 1,5,6,11,14	16, 22, 23, 36-38, 41-43 17-21, 24
	--- -/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the International filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

* & * document member of the same patent family

Date of the actual completion of the international search

25 April 2003

Date of mailing of the international search report

08/05/2003

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3018

Authorized officer

Balsters, E

INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 03/00744

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 426 588 A (WALTERS DAVID W ET AL) 20 June 1995 (1995-06-20) the whole document	1-6
A	GB 2 214 136 A (CROWN WALLCOVERINGS LTD) 31 August 1989 (1989-08-31) the whole document	1, 25-37, 41-43

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Publication No

PCT/GB 03/00744

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5491559	A	13-02-1996	BR 9505095 A EP 0710550 A2 JP 8267997 A JP 10503727 T WO 9614209 A1 US 5671064 A US 5731881 A	21-10-1997 08-05-1996 15-10-1996 07-04-1998 17-05-1996 23-09-1997 24-03-1998
DE 10028055	A	20-12-2001	DE 10028055 A1	20-12-2001
US 4451856	A	29-05-1984	US 4357633 A AT 25557 T AU 6122680 A DE 3071912 D1 DE 3072183 D1 EP 0033731 A1 EP 0164764 A2 JP 3026123 B JP 56500843 T WO 8100320 A1 US 4500929 A US 4450486 A	02-11-1982 15-03-1987 13-02-1981 02-04-1987 07-02-1991 19-08-1981 18-12-1985 09-04-1991 25-06-1981 05-02-1981 19-02-1985 22-05-1984
US 5426588	A	20-06-1995	DE 69501008 D1 DE 69501008 T2 EP 0671260 A1 JP 7261376 A	18-12-1997 10-06-1998 13-09-1995 13-10-1995
GB 2214136	A	31-08-1989	CA 1301540 A1 US 4939994 A	26-05-1992 10-07-1990